

# ELEMENTS OF AN INDUSTRY



# List of Elements

(Showing approximate time of identification & atomic numbers).

## Known in Ancient Times

Carbon	(6)	Copper	(29)	Gold	(79)	Iron	(26)
Lead	(82)	Mercury	(80)	Silver	(47)	Sulphur	(16)
Tin	(50)	Zinc	(30)				

## Discovered Between 1201 - 1300

Arsenic	(38)
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## Discovered Between 1501 - 1600

Antimony	(51)	Bismuth	(83)
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## Discovered Between 1601 - 1700

Phosphorus	(15)
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## Discovered Between 1701 - 1800

Beryllium	(4)	Chlorine	(17)	Chromium	(24)	Cobalt	(27)
Cerium	(58)	Hydrogen	(1)	Manganese	(25)	Molybdenum	(42)
Nickel	(28)	Nitrogen	(7)	Oxygen	(8)	Platinum	(78)
Strontium	(38)	Tellurium	(52)	Titanium	(22)	Tungsten	(74)
Uranium	(92)	Yttrium	(39)	Zirconium	(40)		

## Discovered Between 1801 - 1850

Aluminium	(13)	Barium	(56)	Boron	(5)	Bromine	(35)
Cadmium	(48)	Calcium	(20)	Iridium	(77)	Erbium	(68)
Iodine	(53)	Lanthanum	(57)	Lithium	(3)	Magnesium	(12)
Niobium	(41)	Osmium	(76)	Palladium	(46)	Potassium	(19)
Rhodium	(45)	Ruthenium	(44)	Selenium	(34)	Silicon	(14)
Sodium	(11)	Tantalum	(73)	Terbium	(65)	Thorium	(90)
Vanadium	(23)						

## Discovered Between 1851 - 1900

Actinium	(89)	Argon	(18)	Caesium	(55)	Dysprosium	(66)
Fluorine	(9)	Gadolinium	(64)	Gallium	(31)	Germanium	(32)
Helium	(2)	Holmium	(67)	Indium	(49)	Krypton	(36)
Neodymium	(60)	Neon	(10)	Polonium	(84)	Praesodymium	
Radium	(88)	Radon	(86)	Rubidium	(37)		(59)
Samarium	(62)	Scandium	(21)	Thallium	(81)	Thulium	(69)
Xenon	(54)	Ytterbium	(70)				

## Discovered Between 1901 - 1925

Europium	(68)	Hafnium	(72)	Lutetium	(71)	Protactinium	
Rhenium	(75)						(91)

## Discovered Between 1926 - 1950

Americium	(95)	Astatine	(85)	Berkelium	(97)	Californium	(98)
Curium	(96)	Francium	(87)	Neptunium	(93)	Plutonium	(94)
Promethium	(61)	Technetium	(43)				

## Discovered 1951 Onwards

Einsteinium	(99)	Fermium	(100)	Lawrencium		Mendelevium	
Nobelium	(102)				(103)		(101)

# Introduction

Since earliest times man has been trying to unlock the secrets of nature and in about 400 BC, the Greek Philosopher Democritus propounded the idea that all matter was made up of tiny, invisible particles. By pure philosophical thinking, he arrived at the basic idea of the modern atomic theory. He was however, followed by Aristotle who concluded that all matter was made up of varying proportions of the natural elements—*earth, air, fire and water* - a thought that was to exist right up to the days of the alchemists.

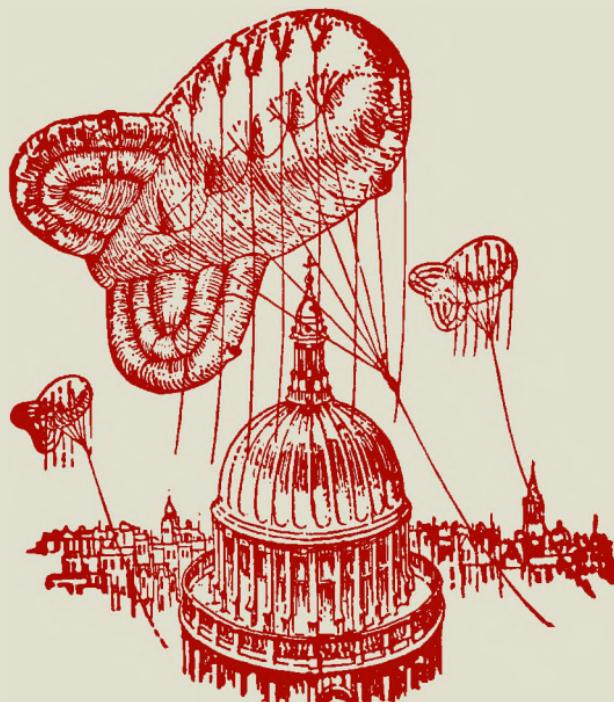
It was two thousand years later that Robert Boyle in 1661 published his theory on which all future chemical reasoning was to be based - the idea that an element was the simplest form of matter, and could not be resolved into any other substance, whilst Isaac Newton restated the early Greek ideas, with his *corpuscular* theory that all substances were made up of tiny indivisible particles.

This paved the way for Dalton who said that all matter consisted of one or more elements and that each element was made up of extremely small but identical atoms, though the atoms of each element were in some way different from the atoms of all other elements.

Gradually this idea was developed and in the 1800's Newlands and Mendeleev contrived to build sets of logical tables based on the properties of the elements. Although there were gaps in the tables indicating elements yet to be discovered the work went on until most of the missing elements had been identified, showing that there are some 90 or so different elements likely to exist in nature. Beginning with hydrogen the lightest, and ending with uranium the heaviest.

In all these theories it was generally considered that atoms were unchangeable, but research by people such as Becquerel and the Curies showed that some elements were apparently undergoing a continuous and natural change. For instance the 88th element - radium, was found to be changing into an inert gas - radon, the 86th element. A typical example of natural radio-active transmutation.

Then in 1919 came the key that unlocked the atom, when by changing nitrogen into oxygen, Lord Rutherford showed that non-radio-active elements could also be transmuted. This was but the beginning, for since then we have seen a tremendous amount of work done in developing methods of obtaining energy by *splitting the atom*. During this period two elements from the atomic table, - No. 61, promethium and No. 43, technetium were first isolated and in addition some new elements were produced - the trans-uranic series - but these latter ones are all unstable and it is for this reason that they are not normally found in nature.



**HYDROGEN** — Schoolboys know that two parts of hydrogen unite explosively with one of oxygen to form water. Hydrogen can be produced commercially in vast quantities by reversing this process. Water, in the form of steam, is split up into its constituent elements by passing it over red hot coke. The carbon in the coke unites with the oxygen in the steam to form carbon monoxide and dioxide. When these are removed from the mixture, hydrogen is left. This method is used to produce hydrogen at the Synthetic Ammonia plants operated by ICIANZ in Australia. Lightest of all the elements, hydrogen occurs free in nature in volcanic gases, but exists in the atmosphere to the extent of only one part in a thousand. Combined with carbon it is present in nearly all animal and vegetable tissues. The high proportion of hydrogen in ordinary coal gas is due to its release from the organic matter from which coal is formed. Industry uses hydrogen in many ways. Some of the vegetable oils used in the manufacture of margarine require hardening by chemical combination with hydrogen. This is done before they are incorporated in the final blend of fats of which margarine is made. Hydrogen is also used in welding and in extraction of metals. In Australia, ICIANZ sells to industry large quantities of hydrogen, made at the Caustic Chlorine plants at Yarraville, Victoria, and Botany in New South Wales.



**CARBON** is one of the most widely distributed of the elements, for it is an essential constituent of all living matter. Carbon appears in the crystalline form as diamond and graphite and in the amorphous form as charcoal. Combined with other elements it gives innumerable chemicals all of which are vital to our existence. Carbon atoms readily join with each other, and with those of other elements. They will link up into rings, form long chains of atoms like strings of beads, and even branch out to make complex dimensional molecules. The study of carbon compounds is so important that it has become a specialized branch of science known as Organic Chemistry. Hundreds of thousands of different molecules have already been made from carbon atoms in conjunction with those of two or three other elements, such as hydrogen, nitrogen and oxygen. An almost infinite number of new ones remain to be discovered by the organic chemist.

Since 1856, when Sir William H. Perkin made the first synthetic dye, mauve, the manufacture of dyestuffs has been a focal point of the organic chemical industry. The dyestuffs made by I.C.I. are carbon compounds, and recent I.C.I. research into carbon derivatives has resulted in such epoch-making discoveries as new anti-malarial drugs, new antiseptics, new insecticides, etc.



**NITROGEN**— In 1898, Sir William Crookes warned the world that the human race might soon starve because intensive cultivation was draining the soil of essential plant foods. Yet, today, agricultural land has become more productive than ever, for the chemist has learned the necessity for returning to the soil the nitrogen and other elements taken up by the plant in its growth.

Nitrogen is a colourless, inert gas that forms four-fifths of the air we breathe. Hundreds of thousands of tons of it are available over every square mile of the earth's surface, but it must first be "trapped" and then combined with other elements before plants can absorb it in the form of fertilizers.

Every day, synthetic ammonia factories in Australia operated by ICIANZ, convert approximately ten tons of nitrogen from the air for the manufacture of a range of products for use in making plastics, commercial explosives, drugs, fertilizers, etc.

From nitric acid, formaldehyde and ammonium nitrate made at the Synthetic Ammonia plant, Deer Park, other ICIANZ factories manufacture commercial explosives, plastic moulding powders and nitrocellulose. This last item is a basic ingredient of paints and lacquers, and it is also used to coat textile materials in making "Fabrex" upholstery material.



**OXYGEN** — is the element that occurs most abundantly in nature. One-fifth of the air consists of oxygen, and without it life could not exist. It is oxygen which causes iron to rust and enables a fire to burn. Discovered in 1774 by Joseph Priestley, and independently by the Swede, William Scheele, oxygen was so named because it was at first believed to be an acid-former. Pure oxygen is produced commercially by liquefying air and then separating the oxygen by distillation. Stored in cylinders, the gas is used in welding and steel-making, as well as to aid breathing in high-flying aircraft and for medical purposes. The importance of oxygen to the chemical industry lies in the fact that substances burn in it to form oxides. Without burning there would be no industrial power, and very little chemical manufacturing would be possible. The oxides enter into almost every phase of chemical manufacture. Sulphur burnt in atmospheric oxygen forms sulphur dioxide, the first step in producing sulphuric acid; whilst nitric acid is made by combining oxygen and ammonia. Combined with carbon, oxygen forms carbon dioxide which in its solid form is important as an industrial raw material and as a refrigerant.



**FLUORINE** — From the famous Blue John mine in Derbyshire comes a mineral called fluorspar. For generations this has been mined in the North of England for use as a flux in metallurgical processes and for making enamels and glass. Today fluorspar has assumed a new importance. It is the chief source of hydrofluoric acid, the compound from which the element fluorine is obtained. Fluorine is chemically so active that it combines with glass and other materials normally used in chemical apparatus. Moissan, the famous French scientist who in 1886 first isolated it, used platinum apparatus which, though attacked, reacted sufficiently slowly to allow him to isolate some free fluorine gas. For over fifty years this elusive element remained a chemical curiosity, but during the war it was needed in large quantities for the manufacture of certain uranium compounds used for the atomic energy projects. The result was so to intensify the research on fluorine chemistry (a great deal of it in I.C.I.'s laboratories) that fluorine is now produced on an industrial scale. Certain fluorine compounds are astonishingly resistant to corrosion and decomposition, a property which is of great value commercially. In Great Britain I.C.I. uses some of these in the manufacture of 'Arclon' refrigerants and 'Fluon', a new plastic material.



**SODIUM** — The element sodium, a soft silvery and highly reactive metal, is never found free in nature but is widely distributed in the form of compounds. The best known of these is sodium chloride or common salt—the raw material from which sodium and many of its compounds are produced commercially. Salt occurs abundantly in sea water and in deposits of rock salt left in the earth's crust by the evaporation of prehistoric seas. Australia's main supplies are obtained from the evaporation of sea water by the sun's heat. Apart from the use of sodium in sodium vapour lamps, a familiar form of street lighting, the element itself is little known outside the chemical industry.

I.C.I. produces sodium for a number of industrial processes, and uses it in large quantities to make sodium cyanide—for gold extraction, case-hardening and electroplating—and sodium peroxide for textile bleaching. In Australia, sodium compounds produced by ICIANZ at Yarraville in Victoria, Botany in New South Wales, and Osborne in South Australia, include such important chemicals as caustic soda, bicarbonate of soda, and soda ash. Caustic soda is essential to the manufacture of soap, paper, textiles, explosives and dyestuffs. Bicarbonate of soda is required by various food industries and for the manufacture of drugs and pharmaceutical products. Soda ash is used in so many different industrial products and processes that it is almost as vital to a nation's industries as coal or iron.

## *Elements of an Industry . . . No. 7*



**MAGNESIUM**, lightest of the common metals and silvery-white in colour, is the element usually associated with photographers' "flash powder", and incendiary bombs. It is produced by the electrolysis of magnesium chloride—a compound made either from sea-water, magnesium-containing brine or mineral deposits of magnesia—and by the thermal reduction of dolomite, a mineral which occurs abundantly in most industrial countries. By far the most important use of magnesium is in the manufacture of castings and wrought alloys for the aircraft and motor industries. It is also used to increase the strength of certain aluminium alloys. Compounds of the element, such as magnesium sulphate (Epsom salts) and magnesium oxide (magnesia), are well-known in medicine. Others are used in the production of rapid-hardening cements, in the rubber industry, in sugar refining and in paper-making. French chalk, meerschaum, asbestos and steatite are all compounds of magnesium. In addition to making electrical insulators of steatite, I.C.I. in Great Britain uses magnesium in the manufacture of the aluminium alloys that are used so extensively in the construction of aircraft and in building and engineering.



**SILICON** — Silicon is, next to oxygen, the most abundant of all the elements in the earth's crust. It is never found free in nature, but occurs, combined with oxygen in quartz, flint, sandstone and many other minerals. Emeralds, aquamarines and the semi-precious stones, amethyst, opal and zircon, all contain silicon. Pure silicon can be produced in two forms — as a hard crystalline solid and as an amorphous brown powder — but it is chiefly important in compounds such as silicon dioxide (silica) and metallic salts of silicic acid, known as silicates. Silica sand, a nearly pure form of silica, is used in glass-making and in the manufacture of silicon carbide, better known as "Carborundum" — an abrasive material almost as hard as diamond. Clay, an important raw material in the manufacture of bricks, pottery and Portland cement, is a compound of silicon, oxygen and aluminium. Silicon is also the basis of the complex organic compounds known as "silicones", now being developed for use in paints, varnishes and lubricants.

Silicate of soda, produced from sand and sodium carbonate, is used as an adhesive in the manufacture of cardboard boxes. It is also used in soap powders, in the surface treatment of concrete, and to make "waterglass" for egg-preserving. In addition, sodium silicofluoride — a by-product of fertilizer manufacture — used in the production of opal glass and vitreous enamels.

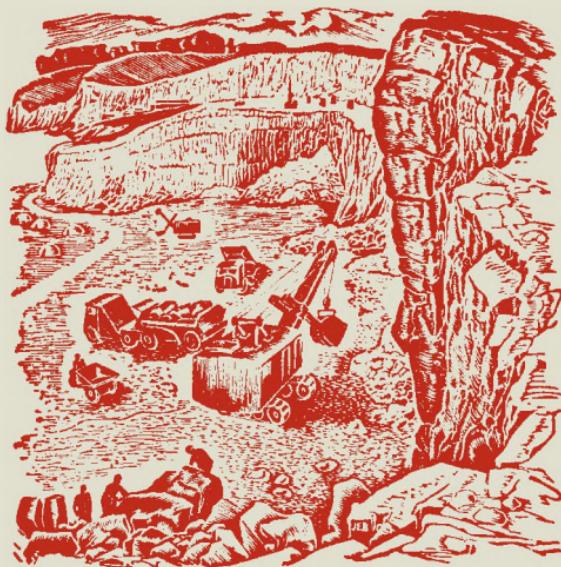


**SULPHUR**—“Bring me fire that I may purify the house with sulphur” wrote Homer in the *Odyssey*. From these ancient medicinal applications, sulphur, in the form of sulphuric acid and other chemicals, has so extended its uses that to-day this yellow rock, which burns to form choking fumes, is one of the most important elements used as a raw material in modern civilisation. In recent times most of the world’s needs for elemental sulphur — amounting to 5·6 million tons annually — have been supplied from deposits in the U.S.A., but these are fast becoming exhausted as more and more sulphur is needed for industrial, agricultural and other purposes.

Since the early 1930s, I.C.I. has been developing methods of making sulphuric acid from anhydrite, which is found in large quantities in many parts of Great Britain. It is fortunate, now that the sulphur situation is critical, that I.C.I. is thus able not only to increase its own production of sulphuric acid from British sources, but also to place its accumulated research and production knowledge at the disposal of some of the principal British acid users. New plants are also going into operation which will make sulphuric acid from this indigenous raw material and thus further reduce the need to import sulphur from overseas. I.C.I. has also converted other plants to utilise the sulphur recovered as spent oxide made in the purification of town gas.



**CHLORINE** — A hundred years ago in Great Britain typhoid fever and cholera were common waterborne diseases. Today cholera is unknown and an outbreak of typhoid makes front page news. This improvement in public health reflects the unremitting care of all concerned with water purification. Of the major defence measures employed against pollution and disease, sterilisation by chlorine is one of the most important. Chlorine is a very active chemical which in nature is found only in combination with other substances, from which it must be isolated. The best known of these is common salt, in which chlorine is combined with sodium. The passing of an electric current through salt splits it into its constituent elements and releases chlorine in the form of a greenish-yellow gas, which is dried and liquefied and so made available for ready transport all over the world. In Australia, the ICIANZ factories at Botany in N.S.W. and Yarraville in Victoria produce large quantities of chlorine from salt. In addition to its uses as a bleaching and a sterilising agent chlorine is also an important raw material in the manufacture of many other items. It is used in the ICIANZ factories to make insecticides, weedkillers, veterinary chemicals, plastics, and industrial chemicals. These items are used in almost every branch of Australia's primary and secondary industries.



## CALCIUM

Next to coal, the most important mineral mined in Britain today is limestone. Like chalk and marble, limestone is a form of calcium carbonate. Calcium itself, though not found naturally in the metallic state, occurs widely in the form of its compounds. Alabaster, anhydrite, gypsum, dolomite and fluorspar all contain calcium. In the human body, a deficiency of calcium sometimes causes rickets. Calcium metal is made commercially by passing an electric current through fused calcium salts, or by reducing lime with aluminium. The metal itself is not much used, but limestone, and the lime made by burning it in kilns, are vitally important.

At Penrice, near Adelaide, ICIANZ operates one of the largest and most up-to-date quarries in Australia, to obtain limestone for use at the ICI Alkali Works at Osborne, S.A.

Minerals containing calcium are used in the manufacture of cement, fertilizers, iron and steel and heavy chemicals. "Slaked lime" — calcium hydroxide — is one of the chemicals used in tanneries to strip the hair from hides. The farmer uses lime to control the acidity of his land.



**CHROMIUM** — the only workable source of the element chromium is chromite, a compound of chromium, iron and oxygen mined in Russia, Africa and Turkey. Chromium is known everywhere as the plating on hardware and motor fittings, but it has other and more important applications. Alloyed with steel, for example, it imparts superior strength and surface hardness, and it is from chromium that stainless steel derives its resistance to corrosion. As well as being the source of chromium, crude chromite ore is used to make heat-resisting firebricks and cements for the construction of furnaces. Chromium derives its name from the Greek “*Xρωμα*”, meaning colour, because its compounds are almost always coloured. Known as chrome pigments, some of these—the chromates of lead, zinc and barium, for example—are used extensively for colouring paints, linoleum, rubber and ceramics. Chromium sulphate is important in tanning, and potassium dichromate in the dyeing of wool, silk and leather. Other chromium compounds are used in photography and in the manufacture of safety matches.

In Great Britain I.C.I. makes a complete range of chrome pigments for the paint, linoleum and rubber industries, besides employing chromium compounds as catalysts in the manufacture of aviation petrol and methanol, an industrial alcohol.



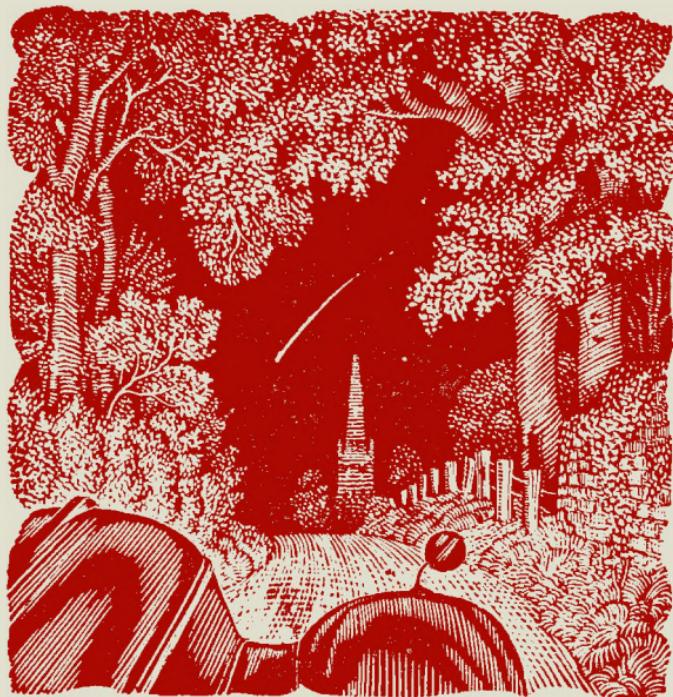
**TITANIUM** — a hard, silver-white metal, is one of the commonest of the elements, but in nature it exists only as a mineral compound. It occurs in many forms, the most abundant being ilmenite—an oxide of titanium and iron found in India, Norway, Australia and the Americas. Ilmenite, coal black in colour, was once used as a black pigment, but, paradoxically, it is also the source of titanium dioxide, the whitest of all white pigments. The most important compound of titanium, superior to all other white pigments in opacity and covering power, is widely used in paints, enamels and printing inks as well as in the manufacture of paper, rubber, linoleum and cosmetics. Compounds such as titanium sulphate and titanium potassium oxalate are well known in textile dyeing. Titanium tetrachloride, which fumes in moist air to form a dense white smoke, is the basis of some compositions used for making smoke-screens. This chemical is also important as a source of pure titanium—a metal which is becoming of great practical value in industry now that it is being produced in commercial quantities. Titanium is made in Britain at the ICI factory at Birmingham. ICI uses titanium dioxide pigments in "Dulux" paints and refrigerator enamels and in the manufacture of "Fabrex" and "Vynex" coated upholstery fabrics.



**IRON**—The element Iron is the most important of all metals and next to aluminium the most widely distributed. It has been estimated that there is an average of 1 cwt. of iron for every ton of the earth's crust. There are many different forms of iron ore, but only four—haematite, magnetite, limonite, and siderite—are of industrial value. Most of the iron ore mined in Australia comes from the haematite deposits at Iron Knob in South Australia, and Yampi in Western Australia. The ore is smelted in a blast furnace with coal and limestone, becoming pig-iron, the raw material from which cast iron, wrought iron, and steel are made. Steel, the strongest metal in common use, is iron containing about 0.15 per cent. carbon and small amounts of other elements.

Although copper and bronze have been used in the world much longer than iron, history shows that over three thousand years ago it was used to make implements and weapons. Today, it is an essential in the structure of civilisation. Without it there would be no railways, steamships, sky-scrappers or machinery as we know them. Apart from its use in the construction of plants and factories, iron, and some of its compounds, are vital to certain chemical processes.

At Deer Park, ICIANZ uses iron as a catalyst for the production of synthetic ammonia, whilst some of its compounds are used in other factories in the manufacture of chemicals. At the same time ICIANZ also supplies a number of chemical products which are essential to the production of iron and steel in their various forms.



**NICKEL** is sometimes found in meteorites, alloyed with iron, but in the earth's crust it does not occur in the metallic state. More than four-fifths of the world's supply of this valuable element is mined in the Sudbury district of Ontario from deposits of "pentlandite" a mineral containing sulphides of iron and nickel. A corrosion-resistant silver-white metal, nickel is well known in the form of nickel-plating, but it is far more important as a constituent of alloys. It is used, for example, in stainless steels and to add strength and toughness to alloy steels for motor cars, aircraft, armaments and machine tools. It is alloyed with copper and other metals to make condenser tubes and coins. Together with zinc and copper it forms nickel silver, the basis of plated tableware, and with chromium it is used extensively in gas turbine engines and to make heating elements for electric fires. Nickel and its salts are also used in alkaline storage batteries and in the manufacture of enamels.

Besides producing large quantities of wrought alloys containing nickel, such as nickel silvers and cupronickels, I.C.I. uses a nickel silver alloy to make "Lightning" slide fasteners, and nickel catalysts in the manufacture of cyclohexane, one of the intermediates from which nylon is produced.



**COPPER**— Next to iron, copper is the most useful metal in the world today. Millions of miles of copper wire and cable carry the electricity that drives motors and transmits messages from one end of the earth to the other. It is made into fireboxes for railway engines and, alloyed with zinc or nickel, into condenser tubes for steam generators in power houses and ships. Alloyed with zinc, copper forms brass, which has a thousand uses from curtain rails to cartridge cases. Alloyed with tin, copper becomes bronze, the alloy that makes springs, statues and heavy duty bearings. Copper was the first metal used by primitive man as he emerged from the Stone Age. When the Romans came to Britain, copper was already being widely used in the form of bronze. Today in Australia the principal copper mines are at Mt. Lyell in Tasmania, and Mt. Morgan and Mt. Isa in Queensland.

In this country ICIANZ uses large quantities of copper in the production of sporting ammunition, slide fasteners, and agricultural chemicals for the treatment of seed grains. In England ICI, the largest producer of wrought non-ferrous metals in the British Empire, manufactures vast quantities of copper and copper alloys in a multitude of forms ranging from printing rollers to coins.



**ZINC**—The element zinc occurs in "zinc blende"—a natural form of zinc sulphide—and in certain ores of lead and silver. A hard bluish-white metal, zinc was originally produced only in China and Sumatra, and substantial quantities were once mined in Britain, but most of the world's supply now comes from the Americas and Australasia. Centuries before zinc was discovered in the metallic form, the Ancient Greeks were smelting its ores with copper to make brass, an alloy that has become indispensable to modern industry. Apart from its use in alloys, zinc is chiefly important to-day for coating or "galvanising" iron sheet and wire to give protection against rust. Zinc is also used as a roofing material and in the manufacture of casings for dry batteries, fittings for motor cars and plates for printing. Compounds of the element are well-known in such diverse fields as medicine, dyeing and paint manufacture. In addition to producing zinc wire and strip for the electrical industry, I.C.I. makes zinc-chrome pigments for paints and zinc compounds for the processing of rubber. In Australia, zinc chloride, produced at the ICIANZ Chemical Factory at Yarraville, is used in the manufacture of soldering fluxes and activating pastes for dry batteries.



**ARSENIC** is a steel-grey, brittle, crystalline substance that is sometimes found free in nature. It also exists combined with sulphur or oxygen as an impurity in the ores of lead, copper or gold, and is produced commercially as a by-product of winning these metals. By far the largest producer is a mine at Boliden in the North of Sweden, but arsenic is also recovered during mining operations in Australia, Brazil, Canada and the United States. Arsenic may suggest weedkillers — or even "Old Lace" — but, though a large amount of the world's output is used for killing weeds and insects, it is also employed in many other ways. It is used, for example, in glass making, and by the textile industries in connection with dyeing and calico printing. Arsenic is also an ingredient of some sheep dips, wood preservatives and medicinal preparations. It is used for hardening the lead shot that is loaded into sporting ammunition, and for making wrought copper alloys of which I.C.I. in England is one of the Empire's largest producers.



**BROMINE** — In ancient Rome, purple was the sign of Imperial rank. The dye they used for colouring their robes came from a sea-snail called *murex brandaris*, found in the Mediterranean. This dye is now known to be a compound of the element bromine—the only bromine compound ever found in a living organism. Bromine, a brown, fuming liquid related chemically to the greenish-yellow gas chlorine, is highly corrosive and dangerous to handle. Its name derives from the Greek *bromos* a stench. Most of the bromine needed by industry today is, like that used by the Romans, extracted from sea-water, but the extraction process is carried out by chemists instead of by sea-snails. During the war I.C.I. helped to develop a factory in Cornwall where bromine is extracted from sea-water to make ethylene dibromide—a chemical used with tetra-ethyl lead in the production of anti-knock petrol. Photography needs silver bromide, which is used in practically all films and plates and many kinds of photographic paper; methyl bromide is employed in one type of modern fire extinguisher, and potassium bromide in medicine.

In Great Britain I.C.I. uses bromine compounds to make some of the 'Caledon' and 'Durindone' dyestuffs used for the dyeing of cotton.



**SILVER** — The element silver sometimes occurs as a free metal, but is obtained mainly from the ores of lead, copper, zinc and gold. A lustrous and beautiful metal, silver has been used for ornament and exchange since the earliest days of history. At Ur of the Chaldees trinkets of silver have been found in royal tombs built more than 5,000 years ago; and the Old Testament relates how Abraham weighed out silver to buy a burial place for his wife Sarah. Silver has been mined in Peru since the time of the Incas but the main sources today are Mexico, the U.S.A. and Canada. Silver is well known in coinage and in such forms as Sterling Silver, and electroplated nickel-silver (E.P.N.S.), but it also has important industrial uses. The best electrical conductor known, it is used extensively to make electrical contacts, and plant for the manufacture of certain chemicals is sometimes lined with silver because of its resistance to corrosion. The important light-sensitive compounds—silver bromide and silver chloride—are the basis of all photography. In Great Britain I.C.I. makes the sodium cyanide used in one method of silver extraction. In Australia, ICIANZ uses silver gauze and granulated silver as catalysts in the production of formaldehyde—one of the basic raw materials of the plastics industry.



**TIN**—The element tin has been known and used since the earliest days of history. Egyptians of the 14th century B.C. alloyed it with copper to make mirrors, and Homer tells in the Iliad how Hephaestus, the god of Fire, used tin to decorate a shield for Achilles. Tin obtained from the moors and streams of Cornwall was the one famous product of Ancient Britain. A natural tin oxide—"cassiterite"—is still mined in Cornwall today, but most of the world's supply comes from alluvial deposits in Malaya and Indonesia and from ores mined in Bolivia, Africa and Australia. By far the most important uses of tin are in the production of tinplate for the canning industry, and the tinning of articles such as milk churns and kitchen utensils. Tin is also an important constituent of alloys such as gun-metal and bronze, and it is used to make bearing metals, soft solder and pewter. Compounds of the element are used in dyeing and medicine, and in the production of glazes and enamels. Besides manufacturing tin dichloride for use in the dyeing and finishing of silk, I.C.I. in England produces large quantities of tinned copper sheet and tubes for dairy and food-producing equipment.



**IODINE** — The element iodine, best known in the form of the antiseptic solution "tincture of iodine", is found only in combination with other substances. Discovered in 1811, it was later identified as one of the elements by Sir Humphry Davy and by the French scientist, Gay-Lussac. Iodine is present in minute quantities in sea water, and is recovered from kelp, the ash of certain kinds of seaweed. Small but valuable quantities of the element are also obtained from brine wells in America and Java, but by far the greater part of the world's supply is extracted from caliche—a natural form of sodium nitrate found in the desert region of Northern Chile. Because iodine is essential to health, it is sometimes added, in the form of potassium iodide, to table salt and animal feeding-stuffs. It is widely used as an antiseptic, and in the treatment of thyroid deficiency. Other iodine compounds play an important part in the sensitising of photographic films and plates, and in chemical analysis.

I.C.I. makes iodised table salt, and iodised salt licks for livestock. It also uses iodine compounds in the manufacture of certain aniline dyes for the textile industry.



**CERIUM** — is one of the group of elements known as the "rare earth" metals, which are very similar to each other in chemical properties. The first steps in the discovery of this element were taken in 1751 when a 15 year old Swedish boy Wilhelm Hisinger sent a sample of rock to the famous chemist Scheele. Hisinger thought that this rock, now known as the mineral "cerite", might contain a new metal; but Scheele failed to find it. More than twenty years later Hisinger himself discovered in cerite the new element cerium. Today the most important sources of the rare earth metals are deposits of monazite sand found in India and Brazil. Pure cerium is rarely produced, but in the form of "Mischmetall" — a mixture of rare earth metals—and in compounds with other elements it has a number of industrial uses. The luminosity of an electric arc light is increased if the carbon electrodes are impregnated with cerium fluoride during manufacture, and ceric sulphate is used in chemical analysis and in photography.

Mischmetall is used extensively to make lighter flints, and in Great Britain I.C.I. produces many millions every year for use in gas and cigarette lighters.



**PLATINUM —** When the Spaniards conquered South America, they found the Indians making white gold. This was an alloy produced by mixing gold with grains of a grey untarnishable metal, now known as platinum, a name given to it by the Spaniards from its resemblance to silver (*plata*). Platinum is gaining ground as a favourite metal for jewellery because, like gold, it retains its lustre and does not rust or corrode. This resistance to atmospheric and chemical attack, combined with its high melting point and ability to promote chemical reactions, has made it a metal extremely valuable to modern industry. Alone or alloyed with other metals, platinum provides electrical contacts and scientific apparatus. Finally, it is so stable that it is chosen for making the standard weights and measures kept by the Board of Trade in London. In Australia copies of these standards are maintained by the National Standards Laboratory in Sydney. Platinum is especially important to the chemical industry, not only in laboratory apparatus, but as a "catalyst" — that is, a substance which assists a chemical process without itself being altered.

ICIANZ uses platinum at the Deer Park Synthetic Ammonia plant in converting ammonia into the nitric acid which is used to manufacture fertilizers, explosives and many other substances.



**GOLD**—most famous of all metals, is the first element mentioned in the Old Testament. As a material for ornaments, it was used in Egypt as early as the Stone Age. As a medium of exchange, it was in use centuries before the time of Croesus—the proverbially rich King of Lydia who, in the 6th century B.C., minted the earliest known gold coins. Although to-day gold is seldom used for coinage, most currencies are still backed by gold, and nearly two-thirds of the world's present gold stock is held for this purpose in the vaults of national banks. Gold is widely distributed in nature but only in Africa, the Americas, Australia and Russia is it found in large quantities. A heavy, untarnishable metal, gold is too soft and malleable for most practical purposes. Alloyed with other metals, however, it is well-known in jewellery and in the form of gold leaf. Because of its outstanding resistance to corrosion, gold is also used in dentistry and in the manufacture of electrical contacts and laboratory apparatus. Compounds of gold are sometimes used in medicine and photography. To extract gold from its ores the method most widely employed is the cyanide process. Discovered in Great Britain in 1887, this process enabled the world's gold output to be trebled within 20 years. I.C.I. makes large quantities of sodium cyanide for gold extraction.



**MERCURY**, also known by its old English name quicksilver, is the only pure metal that is liquid at ordinary temperatures. One of the heaviest of the elements, it is obtained from cinnabar, a compound of mercury and sulphur, which is mined in Italy, Spain and the Americas. The best known use of mercury is in thermometers and barometers, but its ability to dissolve certain other metals makes it of importance in the chemical industry, and in gold-mining where it is used in one method of extracting gold. Compounds of mercury have many uses. Both mercurous and mercuric chloride play an important part in medicine -- Paracelsus, the Swiss physician, was using mercury compounds early in the sixteenth century. In agriculture they are used in the manufacture of seed dressings. Oxides of the metal are used in special marine paints, and the bright scarlet pigment, vermillion, is made from mercuric sulphide. Fulminate of mercury, a powerful explosive, is used in the manufacture of detonators.

ICI uses mercury in the production of caustic soda and chlorine at the chemical plants at Botany, N.S.W., and Yarraville, Victoria. It also uses compounds of mercury to make plastics, dyestuffs and other chemicals, including phthalic anhydride, one of the intermediates used in the manufacture of the brilliant 'Monastral' blue pigment.



**LEAD**, one of the heaviest of the elements, is found in many parts of the world as galena or sulphide of lead. Australia's main supplies of lead come from the mines at Broken Hill. Lead was one of the first metals to be worked by Man. The baths of ancient Rome were supplied with water through pipes made of lead, and for centuries it has been used as a roofing material. Soft, easy to shape and resistant to corrosion, lead is still employed for these purposes, but today it has many other important uses. Large quantities alloyed with antimony are now used to make plates for electric accumulators and to protect insulated cables. Soft solder is an alloy of lead and tin, and alloys of copper, tin and lead are used for bearings. Litharge, an oxide of lead, is used in making flint glass, pottery glazes and in the processing of rubber. Red lead, another oxide, and white lead, or lead carbonate, are well known in the manufacture of paint. In the chemical industry, plant and equipment for the manufacture and storage of sulphuric acid are lined with lead because of its resistance to corrosion. I.C.I. in England make wrought lead products such as sheet, pipes, tape and wire for a wide variety of purposes. In Australia, lead is required by ICIANZ for numerous chemical processes and also for the manufacture of shotgun and rifle ammunition.



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